8th International Conference on Fog, Fog Collection and Dew
Taipei, Taiwan, 14–19 July 2019
IFDA2019-90-3

Cloud water interception in Hawai‘i: project overview & preliminary results of fog and CWI patterns

Han Tseng (1), Thomas Giambelluca (1), John DeLay (2), and Michael Nullet (1)

(1) University of Hawai‘i at Mānoa, Department of Geography and Environment, Honolulu, Hawai‘i, United States, (2) University of Hawai‘i, Honolulu Community College, Honolulu, Hawai‘i, United States

Tropical montane cloud forests (TMCFs) are ecosystems distinguished by their frequent and consistent immersion of clouds at the vegetation level. Cloud water interception (CWI) is an ecohydrological process unique to these fog-affected systems. During CWI, the cloud water droplets moved by wind are intercepted upon impacting the leaf or stem surface of plants and can accumulate in the vegetation canopies. CWI can play an important hydrological role by adding fog water on top of rainfall, thus enhancing below-canopy net precipitation, sometimes to significant amounts.

Although fog has long been recognized as the key factor shaping TMCF ecosystems, our understanding about the influence of fog and CWI on hydrology is still limited. This is mainly because CWI is hard to quantify at scales relevant to most hydrological questions. The controlling factors of CWI, namely the vegetation structural characteristics, fog frequency and density, and wind conditions, are highly variable across space and time so that point measurements are not easily extrapolated. Since the 1960s, CWI research in Hawai‘i has been motivated by the need to better understand the contribution of fog to water resources. Until recently, most studies in Hawai‘i have been done at isolated locations and results have been restricted to relatively small spatial extents, making comparisons and generalization difficult.

The “Cloud Water Interception in Hawai‘i” project is the latest effort aiming to fully characterize the spatial-temporal patterns of fog and the ecohydrological significance of CWI. With the goal of mapping CWI throughout the Hawaiian Islands, we seek to quantify fog patterns, model vegetation controls over CWI, and estimate CWI using an empirical model and spatial datasets. We made ground-based observations of cloud liquid water content (LWC) using fog gauges at five locations spanning a range of elevations on three different islands. These observations are used to validate LWC predicted by the Hawai‘i Regional Climate Model. We then estimate CWI at the same five locations, which also cover the major native ecosystems, using two independent methods: the wet canopy water balance (WCWB) and an empirical model by Katata et al. (2011) driven by the fog gauge-derived LWC observations. The CWI model estimates can then be compared against WCWB to adjust model parameters for the Hawaiian vegetation. Finally, we can use the calibrated empirical model to map CWI using spatial vegetation characteristics data and LWC and wind speed data from the climate model output.

Preliminary analyses revealed large variations in fog frequency (4 - 52% of the hours), the diurnal cycle, and the horizontal fluxes of cloud water (0.2 - 13 mm per hour per unit vertical area) among sites. These patterns do not completely correspond to those of rainfall, suggesting fog might contribute differently from rain to the hydrological regimes.